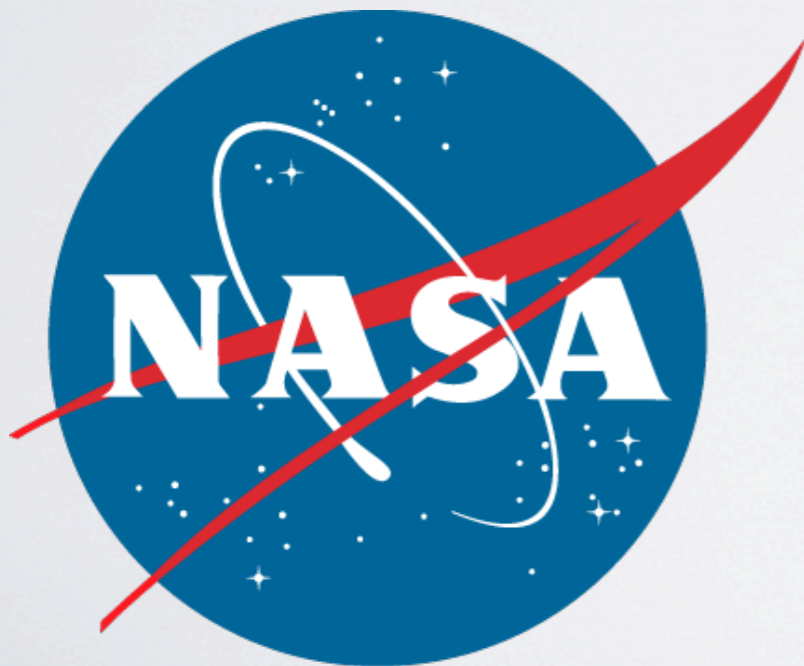


The NASA GEOS-5 Aerosol Forecasting System



Peter Colarco¹, Ed Nowottnick^{1,2},
Arlindo da Silva³

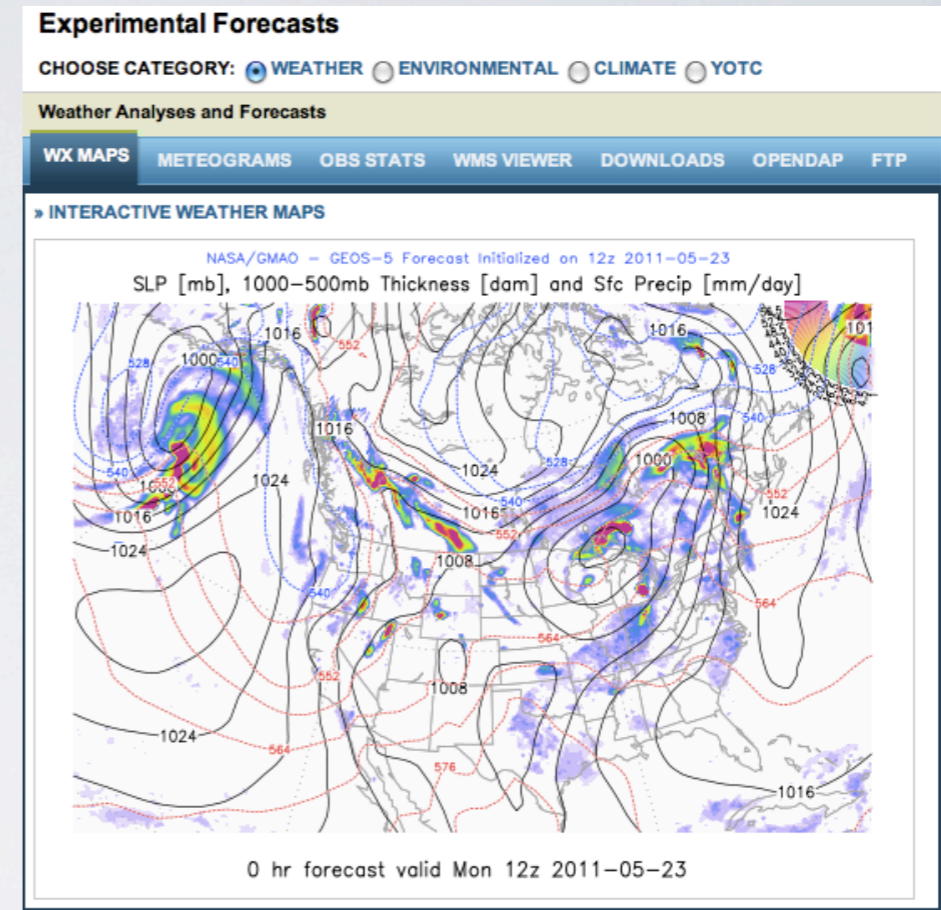
¹NASA GSFC, Atmospheric Chemistry and Dynamics Branch

²NASA Postdoctoral Program/ORAU

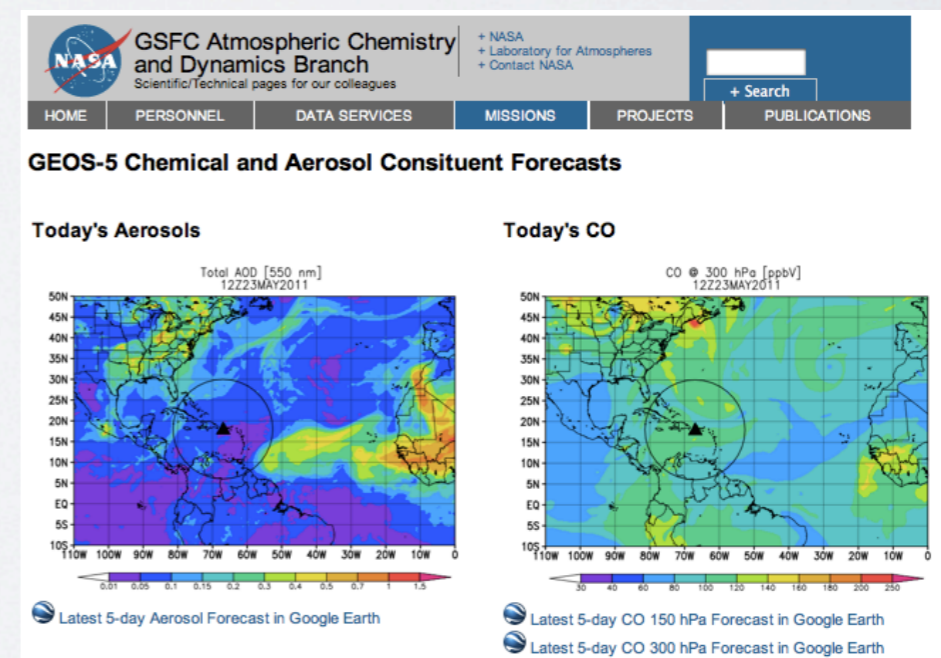
³NASA GSFC, Global Modeling and Assimilation Office

What We Are Providing

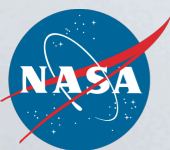
- GEOS-5 is the NASA GSFC global Earth system modeling and data assimilation system
 - incorporates online aerosol and chemistry modules
 - high resolution meteorological analysis and chemical weather forecasting
 - reanalysis and chemistry-climate modeling
- For HS3 GEOS-5 will provide
 - Twice daily, 5-day forecasts of meteorology and aerosols
 - Products are available on web pages and via several data services
- Aerosol forecasts include
 - Dynamical dust sources
 - Satellite-based estimates of biomass burning emissions
 - Assimilation of MODIS aerosol data



<http://gmao.gsfc.nasa.gov/forecasts/>



http://acdb-ext.gsfc.nasa.gov/People/Colarco/Mission_Support



Our Instrument

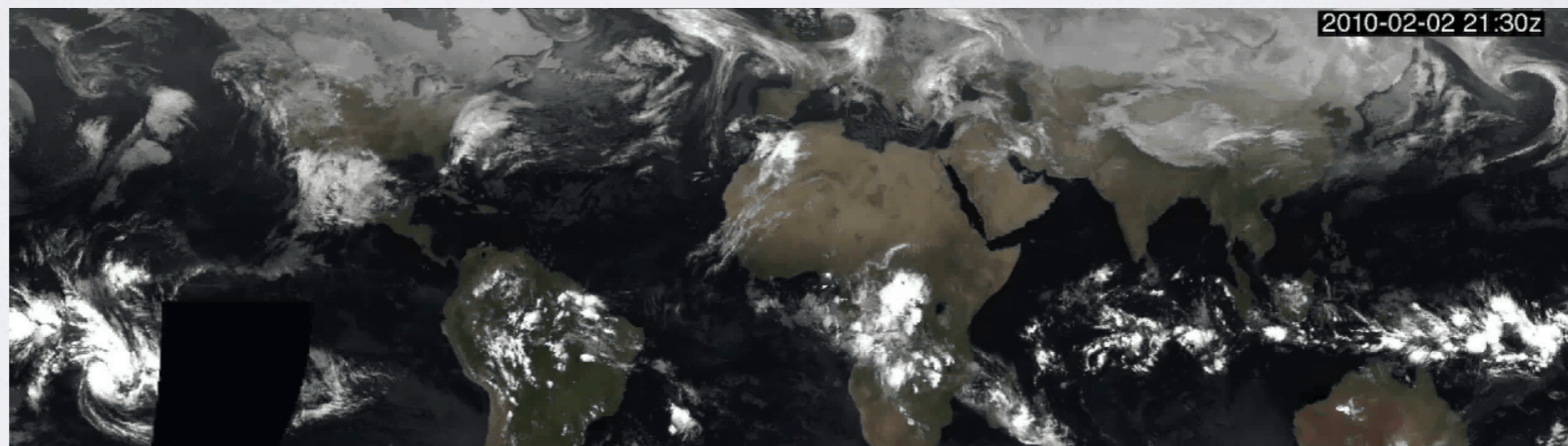


- GEOS-5 model is run on Discover at NASA Center for Climate Simulations (NCCS)
- System runs on SLES (Linux) OS, PBS job scheduler, Fortran 90 code-base with ESMF
- Runs on 90 8-core 2.8 GHz Intel “Nehalem” nodes (720 CPUs, 24 GB RAM per node)

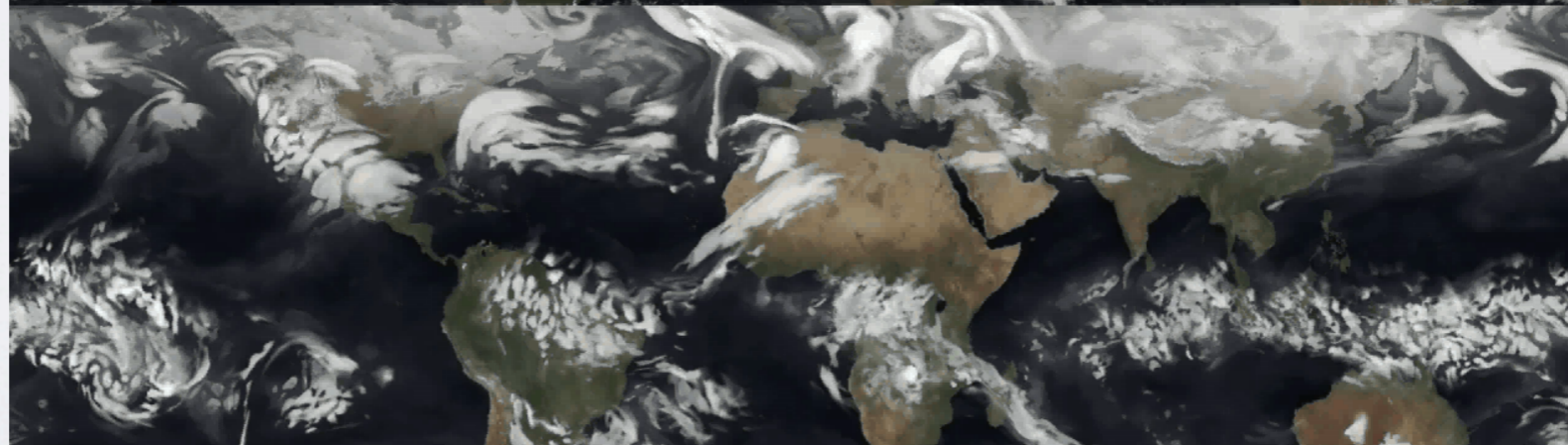
GEOS-5

- Goddard Earth Observing System Model, Version 5
- Atmospheric analysis integrates the AGCM with the Gridpoint Statistical Interpolation (GSI) package (NASA/NCEP/EMC)
- Aerosols and chemical tracers carried online (radiatively interactive) within the AGCM
- Operational system is running twice-daily 5-day forecasts
- Model resolution is Global, $0.25^\circ \times 0.3125^\circ$, 72 hybrid η levels

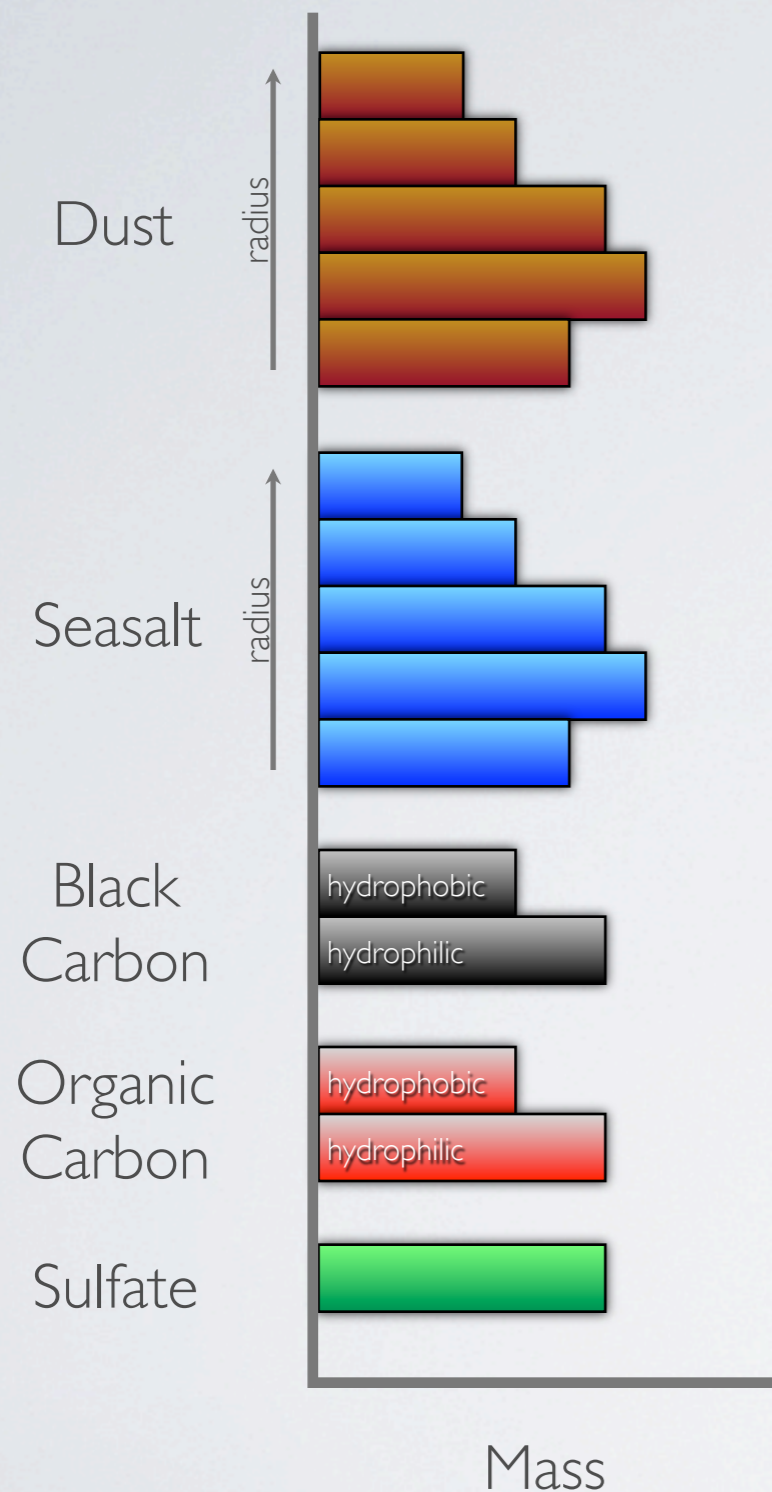
Geostationary
IR Imagery



GEOS-5 5 km OLR
Cubed-Sphere



Aerosol Module



- Goddard Chemistry, Aerosol, Radiation, and Transport Model [Chin et al. 2002]
- Sources and sinks for 5 non-interactive species

dust	wind and topographic source, 5 mass bins
sea salt	wind driven source, 5 mass bins
black carbon	anthropogenic and wildfire source, mass hydrophobic and hydrophilic
organic carbon	anthropogenic, biogenic, and wildfire source, mass hydrophobic and hydrophilic
sulfate	anthropogenic and wildfire source of SO ₂ , oxidation to SO ₄ mass

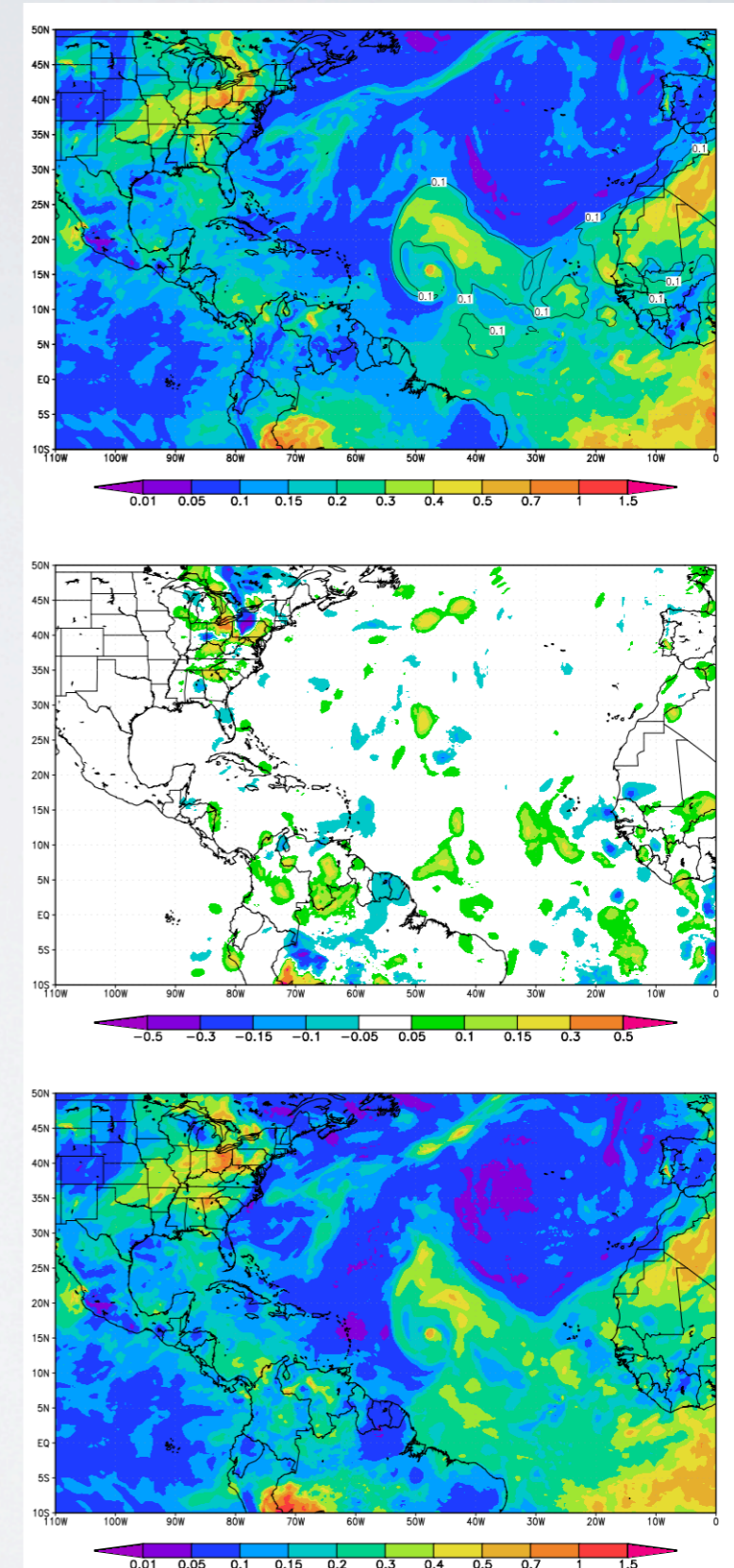
- Wet removal: convective updrafts and large scale precipitation
- Dry removal: turbulent deposition and sedimentation (dust and sea salt only)
- Optics based primarily on OPAC

Aerosol Assimilation

GAAS: GEOS-5 Aerosol Assimilation System

- Assimilates MODIS-based aerosol optical thickness
 - Land and ocean, Terra and Aqua
 - other sensors (e.g., MISR) in development
- MODIS observations subject to additional QA
 - Attempt to correct biases in MODIS AOT
 - Adaptive statistical quality control (Dee et al., 1999)
 - ▶ State dependent, adapts to error of the day
 - ▶ Background and buddy check based on log-transformed AOD
 - Error covariance models (Dee and da Silva, 1999)
 - ▶ Innovation based
 - ▶ maximum likelihood
- Lagrangian displacement ensemble technique captures, e.g., plume misplacements
- Result is updated aerosol tracer mixing ratios every 3 hours

Example: Sept. 1, 2011

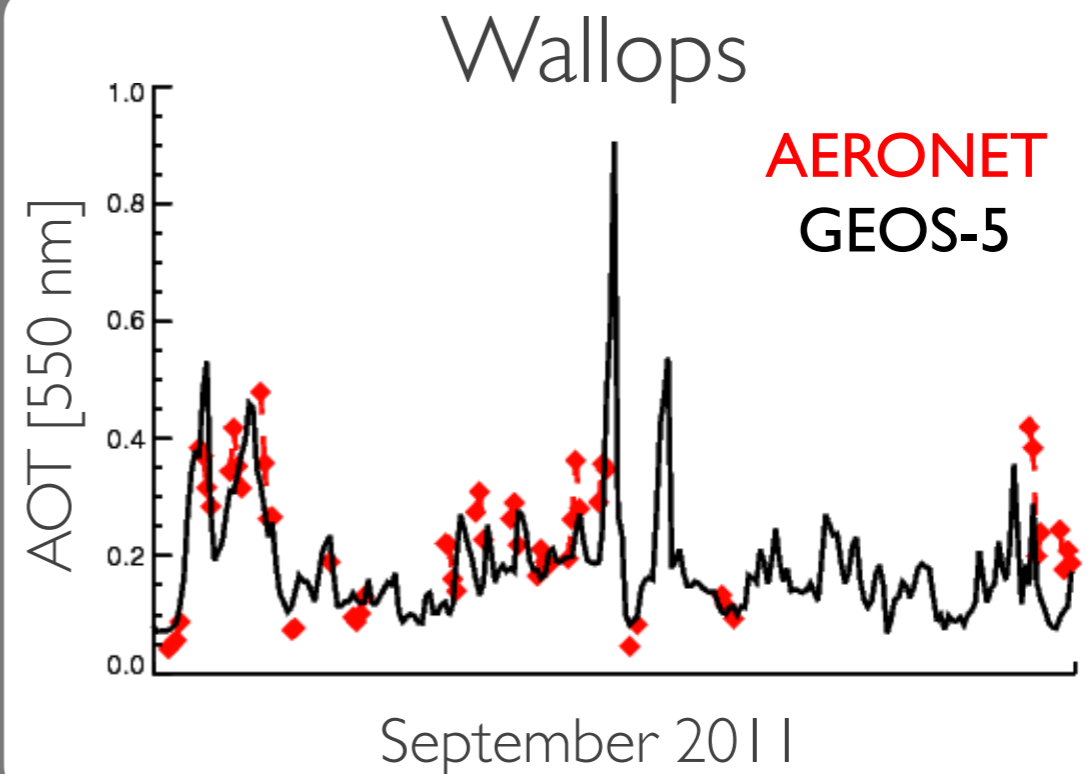
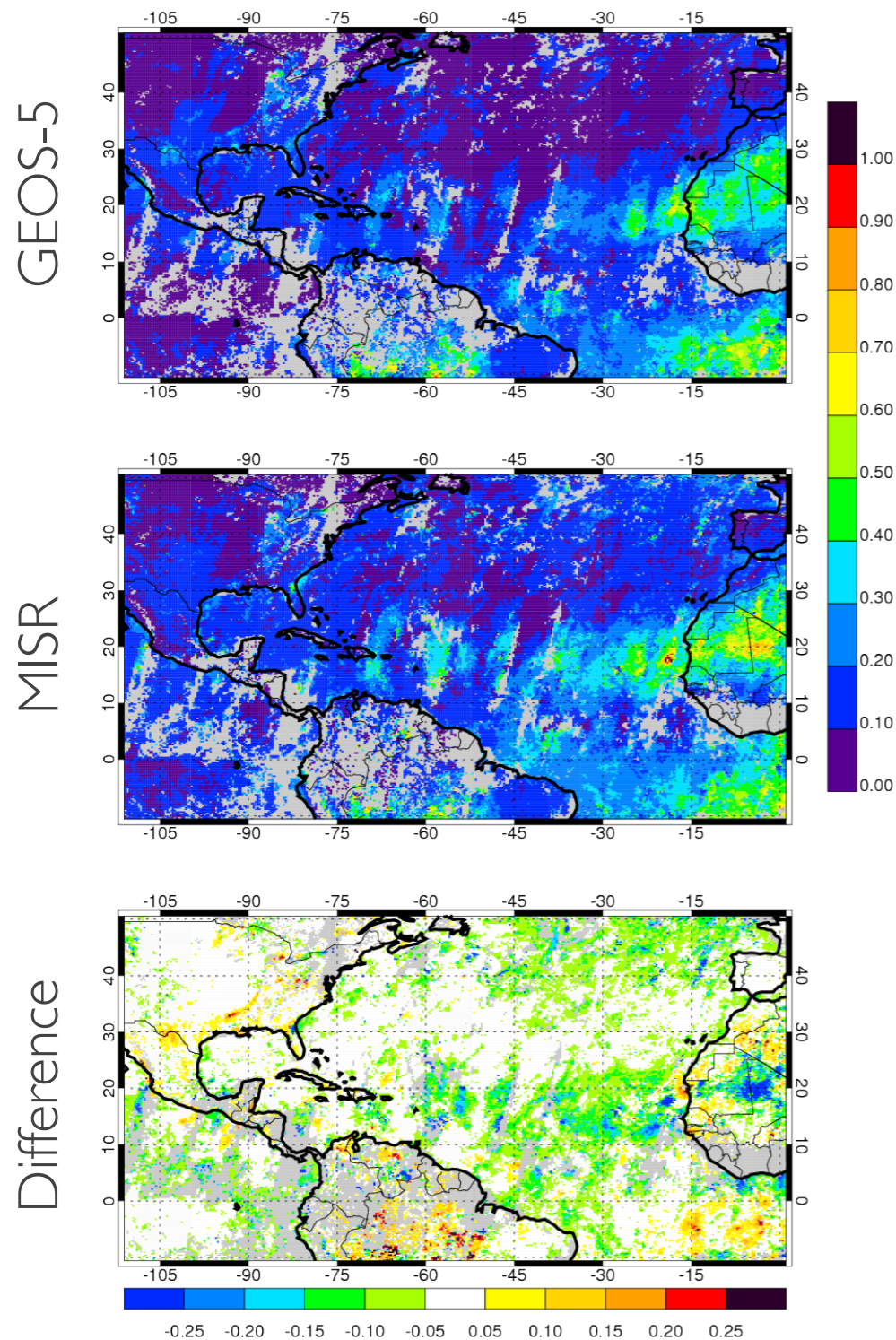


Forecast

Correction

Analysis

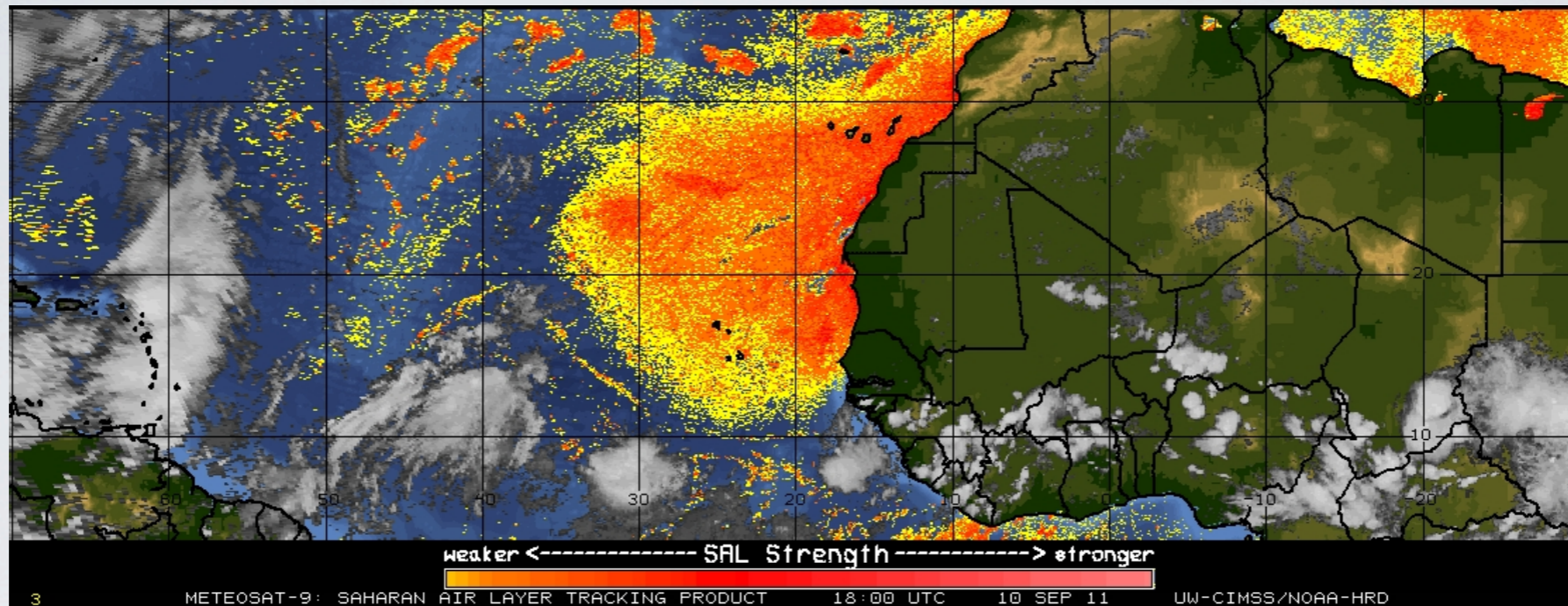
Product and Evaluation (i)



- GEOS-5 is compared to independent observations from MISR and AERONET
- GEOS-5 underestimates MISR under dust plume
- GEOS-5 shows consistency with AERONET at Wallops

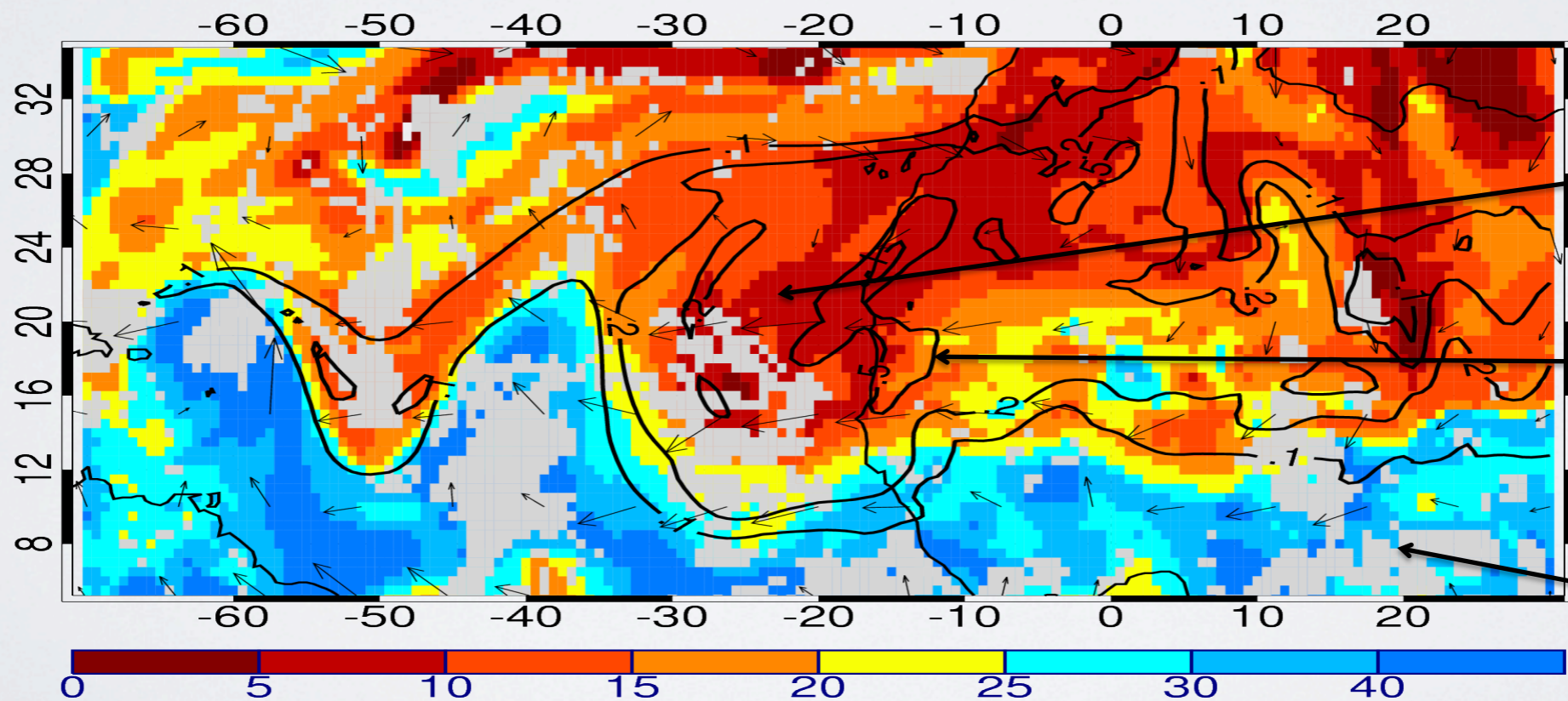
Product and Evaluation (ii)

CIMSS SAL Product
September 10, 2011 18Z



Courtesy of CIMSS Tropical Cyclones Group – University of Wisconsin-Madison

GEOS-5 RH Product
September 10, 2011 18Z



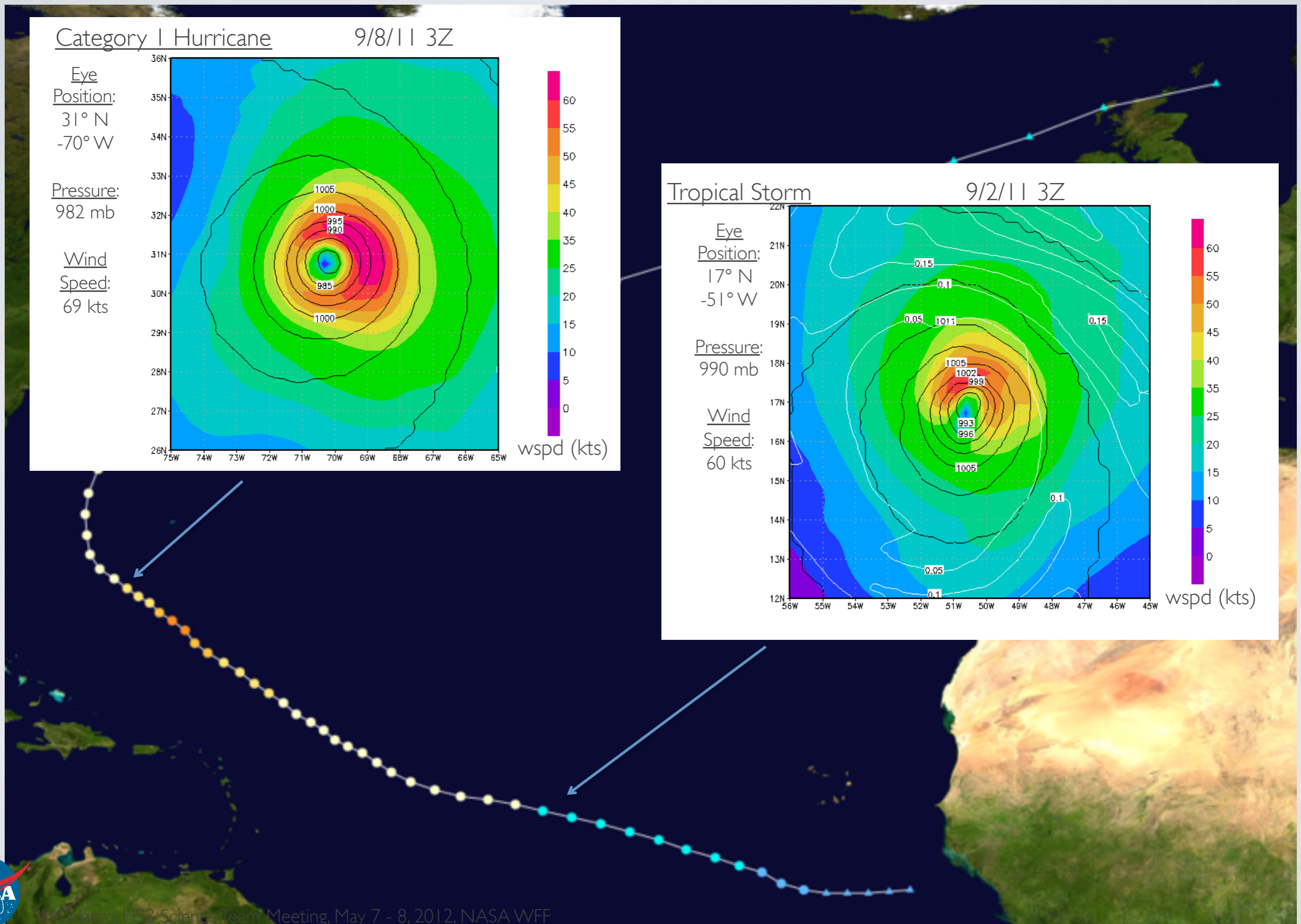
850 – 650
mb mean
RH (shaded)
and winds
(vectors)

Dust AOT
(contour)

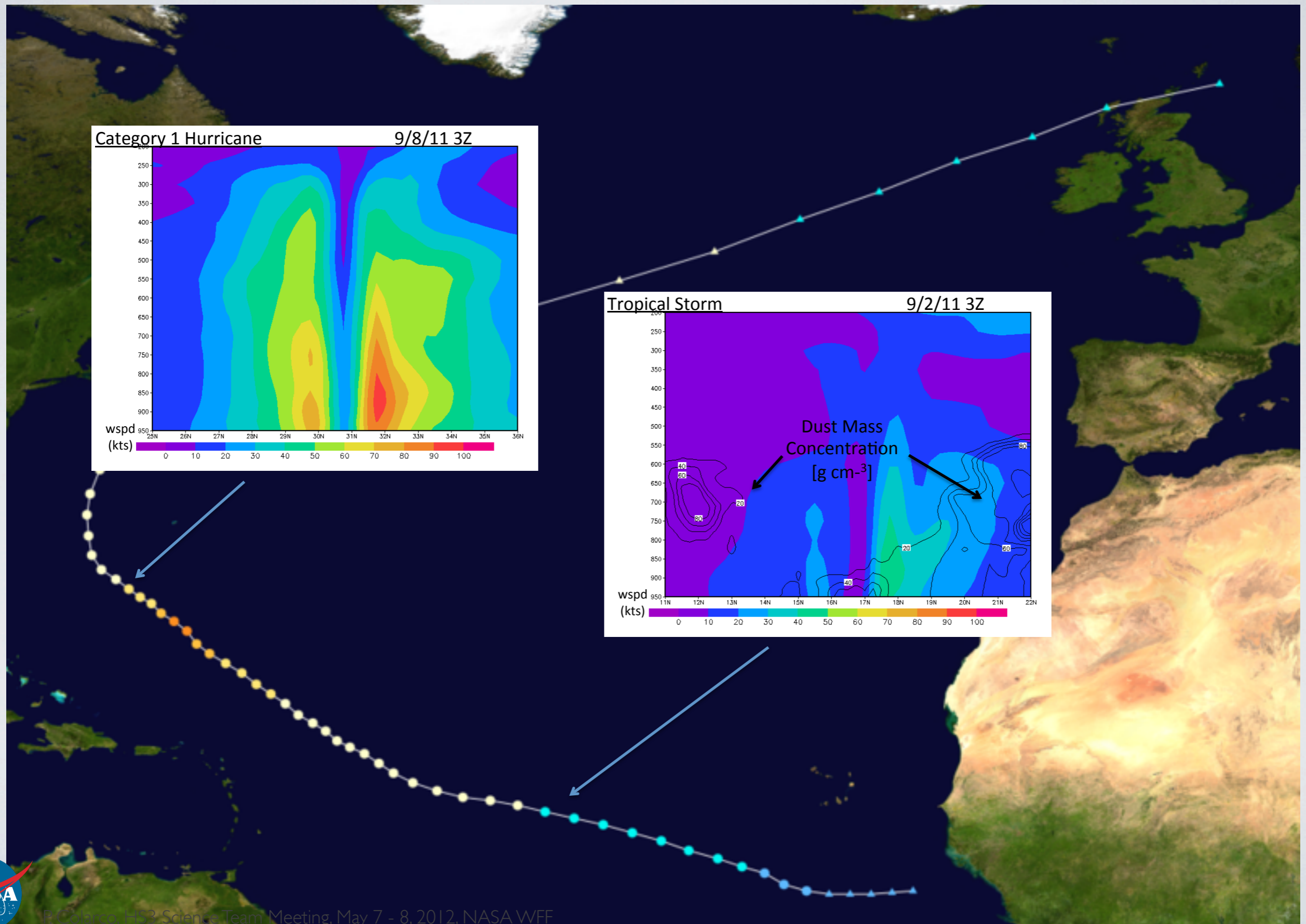
Clouds



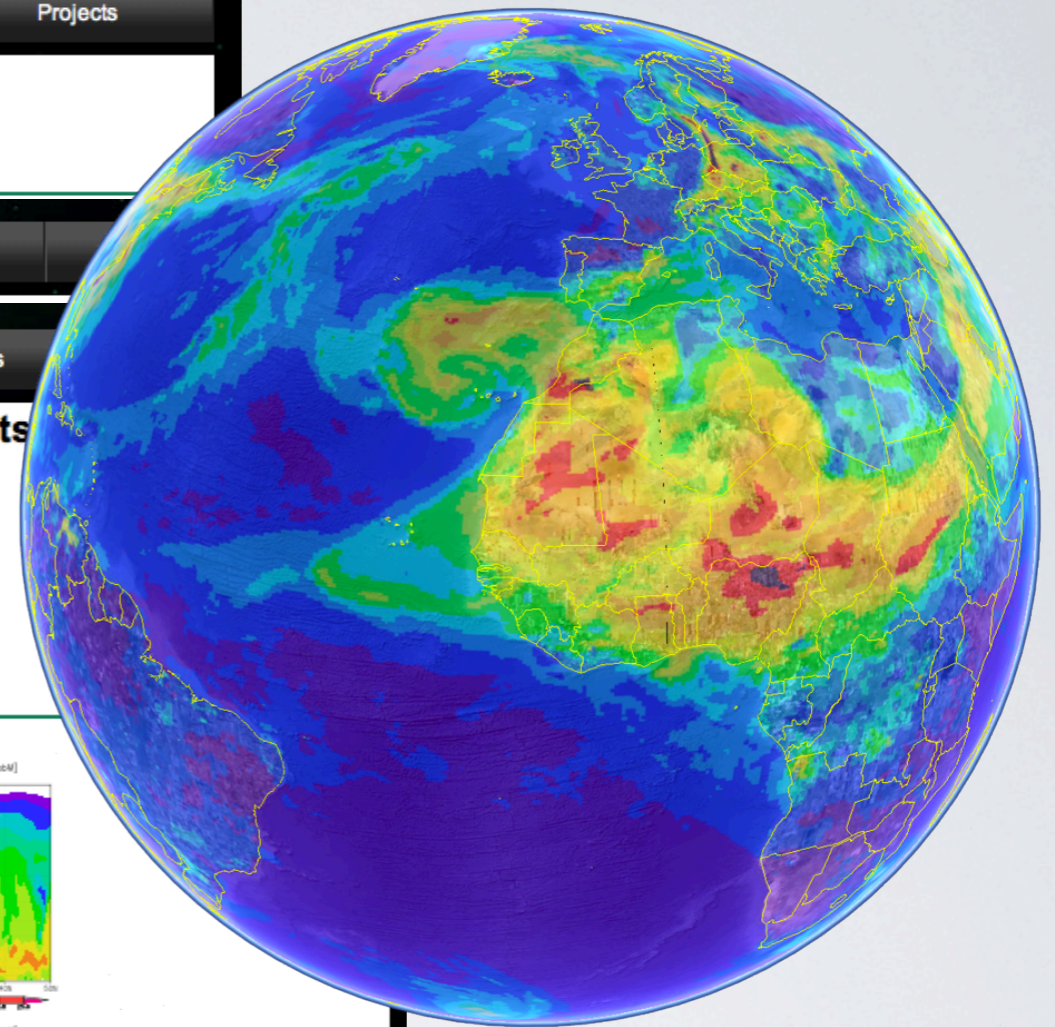
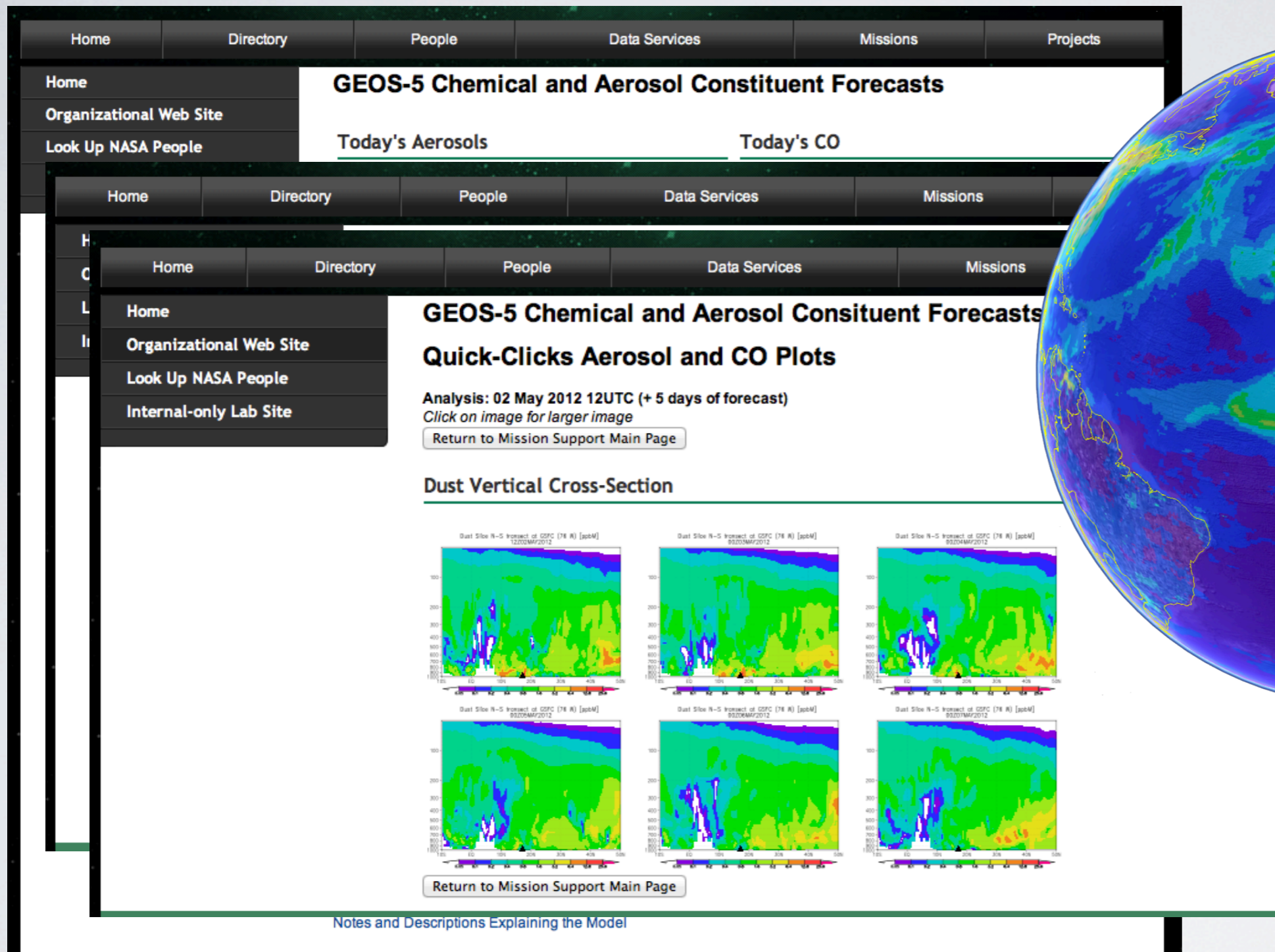
Science: Hurricane Katia Analysis (i)



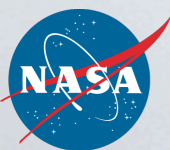
Science: Hurricane Katia Analysis (ii)



Products



http://acdb-ext.gsfc.nasa.gov/People/Colarco/Mission_Support/



Products

Global Modeling and Assimilation

Research

Systems

ENVIRONMENTAL FORECASTS

Interactive ChemWX Maps

Data via OPeNDAP:

GEOS-5 Assimilation

GEOS-5 Forecast

EOS Sat. Aerosol Obs.

Data via FTP: (Do NOT enter a password)

GEOS-5 Assimilation

GEOS-5 Forecast

Global Modeling and Assimilation

Experiment

IMPORTANT purposes of

CHOOSE CATEGORY

Environment

CHEMWX

INTERACTIVE CH

NASA/GMAO - GEOS-5 Forecast Initialized on 00z 2012-05-03

Dust Aerosol Optical Thickness

0 hr forecast valid Thu 00z 2012-05-03

NASA

[GMAO Experimental Forecast Suite](#)
[GMAO Envirograms](#)

Site Developers: *Arlindo da Silva / Tommy Owens / Joon Yoon / Austin Conaty, GSFC 610.1*
Responsible NASA Official: *Michele Rienecker, GSFC 610.1*
[Privacy Policy and Security Notice](#)
Site Updated: 2010-06-28

Map Regions
Global
HS3
Mid-Atlantic
Northern Polar
Pacific
North America

GMAO 2D ChemMaps

Forecast Initial Time

2012-May-03 00z

Forecast Lead Hour

000

Models

GEOS-5

Variables

CO Column

CO Biomass Burning Eurasia

CO Biomass Burning Africa

CO Biomass Burning South America

CO Biomass Burning North America

CO Biomass Burning Other Regions

CO Fossil Fuel Asia

CO Fossil Fuel Europe

CO Fossil Fuel N. Amer.

CO Surface

Dust AOT

Fine AOT

Total AOT

SO2 Column Mass

SO2 Surface Mass

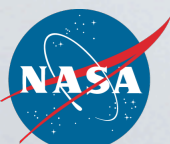
Total Ozone

Animate

All τ for Dust AOT

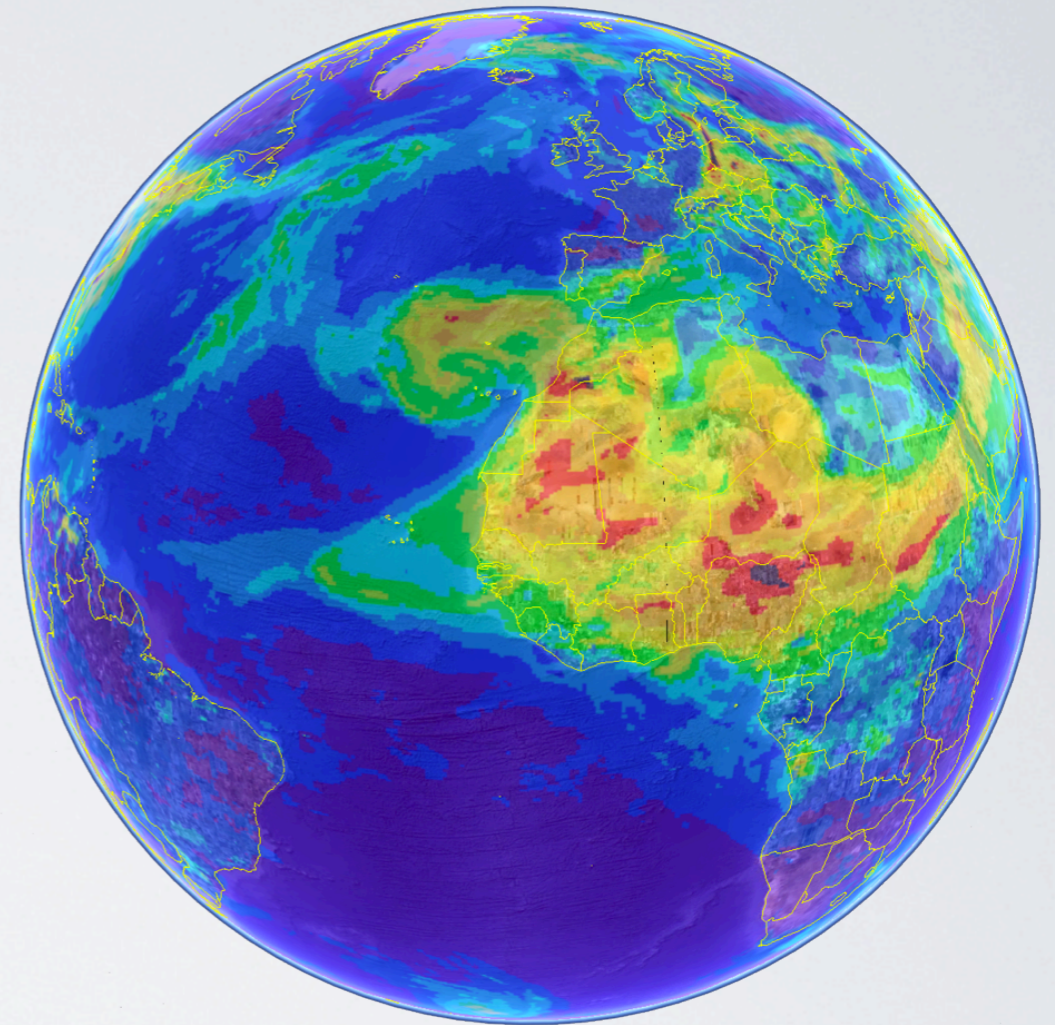
All Products for $\tau=0$

<http://gmao.gsfc.nasa.gov/forecasts/>



Summary

- Model runs 2x daily, 5-day forecasts
 - 0Z forecast starts about 6:30Z (2:30 AM local), products completed about 10:30Z (6:30 AM local)
 - 12Z forecast starts about 18:30Z (2:30 PM local), products completed about 22:30Z (6:30 PM local)
- Near-Realtime Products (web)
 - http://acdb-ext.gsfc.nasa.gov/People/Colarco/Mission_Support/
 - <http://gmao.gsfc.nasa.gov/forecasts/>
- Products also available via opendap
 - http://opendap.nccs.nasa.gov:9090/dods/GEOS-5/fp/0.25_deg/assim
 - http://opendap.nccs.nasa.gov:9090/dods/GEOS-5/fp/0.25_deg/fcast
- Or by ftp (no password)
 - ftp://gmao_ops@ftp.nccs.nasa.gov/fp/das/
 - ftp://gmao_ops@ftp.nccs.nasa.gov/fp/forecast/



Experimental Forecast Suite

Global, $0.25^\circ \times 0.3125^\circ$, 72 hybrid η levels
2x daily, 5-day forecasts of meteorology, aerosols, CO

GEOS-5 Structure

